



# **DRAINAGE DESIGN MANAGEMENT SYSTEM FOR WINDOWS VERSION 5.3.0**

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## **TUTORIAL # 1 DEVELOPING A NEW HEC-1 MODEL**

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**KVL Consultants, Inc.**

## DEVELOPING A NEW HEC-1 MODEL

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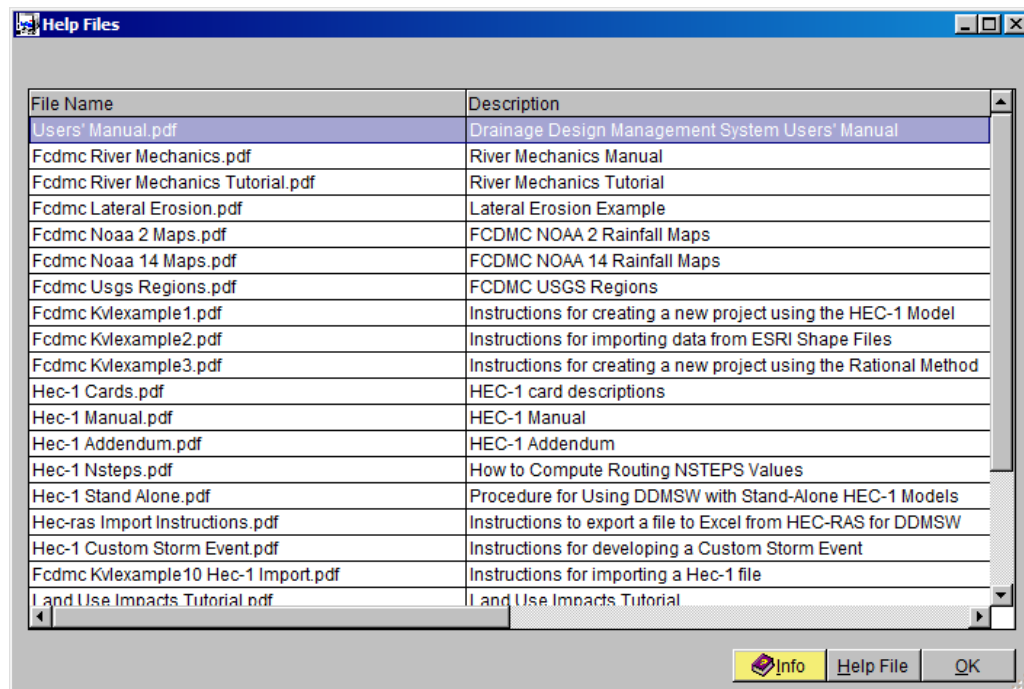
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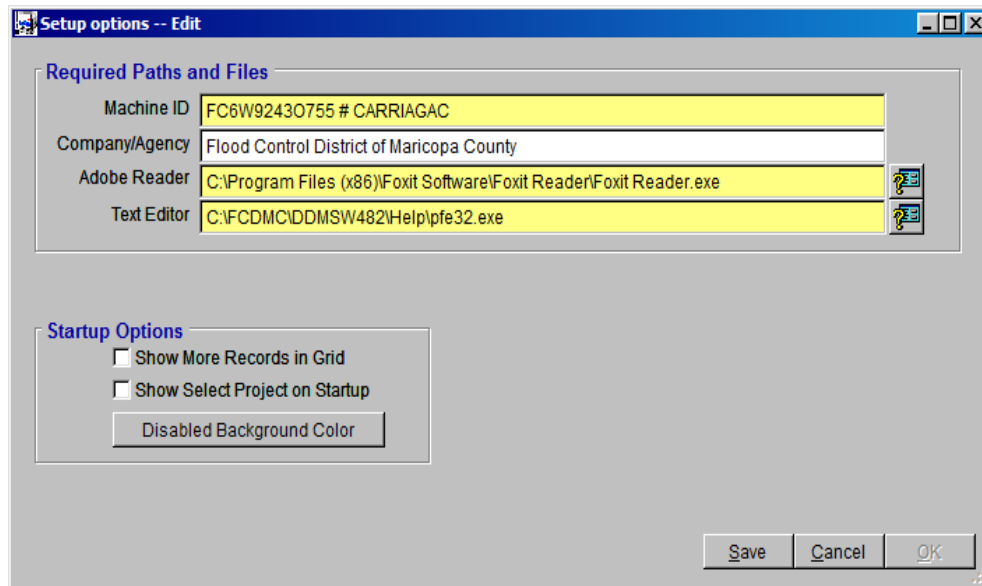
# DEVELOPING A NEW HEC-1 MODEL

DATE UPDATED: APRIL 22, 2016

## 1.0 USING THE HELP FEATURE OF DDMSW

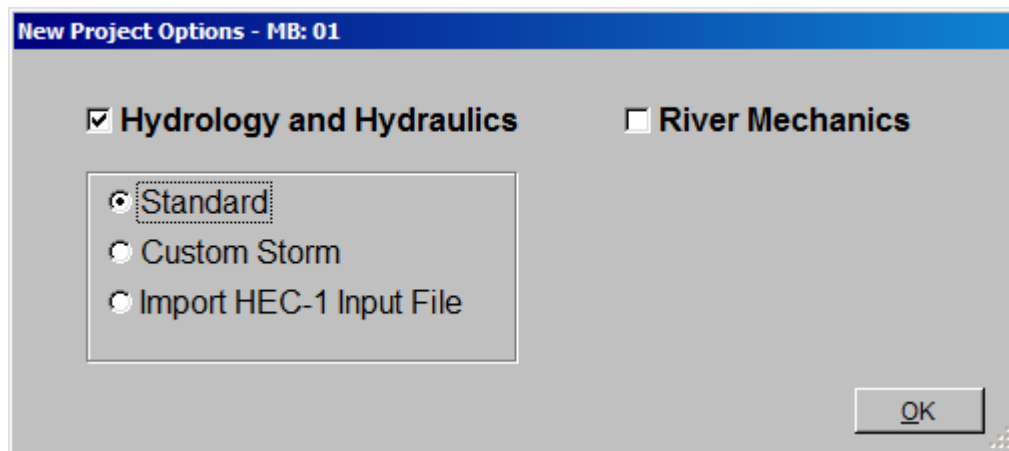
Launch the DDMSW program. Go to the '**Help**' menu and go to the '**Other Help Files**' submenu. For the remainder of this tutorial, this step process will be abbreviated through the use of the following convention i.e., **Help → Other Help Files**. You can read the DDMSW User's Manual by selecting the file titled, '**User's Manual**' and pressing the '**Help File**' button at the bottom of the form. This will launch Adobe Acrobat Reader (or Foxit Reader) and open the **DDMSW User's Manual** document. If your computer does not have Adobe Acrobat or Adobe Acrobat Reader installed, please contact your IT Department. After the Adobe Acrobat Reader or Foxit Reader program is installed, the DDMSW Program should point to the Acrobat or Foxit executable file, under **Tools → Options → Adobe Reader**. Additionally, there is a text editing program (e.g., Notepad, PFE Editor, or Textpad) identified under **Tools → Options → Text Editor**. It will be used to read text files used by DDMSW. The path and file names in the 'Adobe Reader' and 'Text Editor' fields shown on the figure below are not necessarily the same as the users' path. The paths and file names are the specific locations where the above programs are installed.





## 2.0 ESTABLISH A NEW PROJECT AND SET DEFAULTS

Select **File** ➔ **New Project**. On the **NEW PROJECT OPTIONS** form, select the **Hydrology and Hydraulics** checkbox, and the **Standard** radio button as shown. Click the **OK** button to close the dialog box.



On the **SELECT PROJECT** form, fill in the fields using the data shown on the screen capture provided below. Each project must have a unique **Reference** (without spaces) name. **Title**, a project **Location** and an **Agency** name (this can be your firm's name if you are a consultant) are optional data. On the **Project Defaults** data group, select the appropriate **Model** ('*HEC1*' or '*Rational*', but select '*HEC1*' for this example), data sources for **Soils**, **Land Use**, **Roads**, and **Rainfall** data. Finally, on the **HEC-1 Defaults** data group, select the appropriate HEC-1 **Loss Method**, the **Unit Hydrograph** method, **Storms**, and **Duration**. Model parameters such as **Tab Interval (NMIN)**, **No of Ordinates (NQ)** and printing **Output (IO)** level are required.

As shown, there are three checkboxes in the **Project Reference** data group identified as **Hydrology and Hydraulics Only**, **Custom Storm Event**, and **Imported HEC-1 File**. Only the **Hydrology and Hydraulics Only** checkbox should be checked for this tutorial.

On the “Return Periods to Model” data group, six (6) default event settings are provided. They are: *2-year*, *5-year*, *10-year*, *25-year*, *50-year*, and *100-year* storm events from which the model will generate respective hydrographs and peak flows. For this tutorial, leave the default values as shown.

On the Comment box, add any appropriate comments that may include a brief description of the model, assumptions used, documentation of data sources, or other information that maybe helpful or crucial to understanding the model when the user revisits the model after a hiatus.

On the **Modification Data**, the user can now select the date when the model was developed, modified, or updated. This is to provide a timeline when the model was last accessed, used, or ran.

**Select Project**

**List**

**Project Reference**

Project ID: 00108 Reference: KVLEXAMPLE1

Title: Example 1 HEC-1 tutorial project

Location: Maricopa County

Agency: KVL Consultants, Inc.

☐ River Mechanics Only ☐ Custom Storm Event

☐ Imported Hec-1 File

**Return Periods to Model**

1. 2. 3. 4. 5. 6.

2 5 10 25 50 100

This project is the tutorial example for establishing a new project using HEC-1.

**Details**

**Project Defaults**

Model: HEC1

Soils: FCDMC

Land Use: FCDMC

Rainfall: NOAA14

Roads: MCDOT

**HEC-1 Defaults**

Unit Hydrograph: Clark

Loss Method: Green-Ampt

Storms: Multiple

Duration: 6 Hour

Tab Interval (NMIN): 5

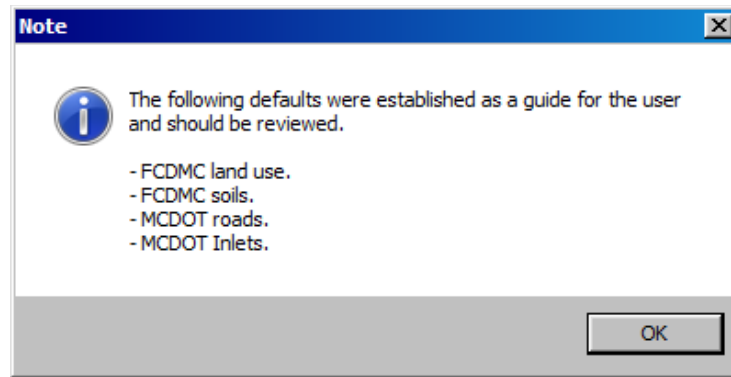
No. Ordinates (NQ): 2000

Output (IO): 5

Modification Date: 12/08/2014

Info Print... Delete Add OK

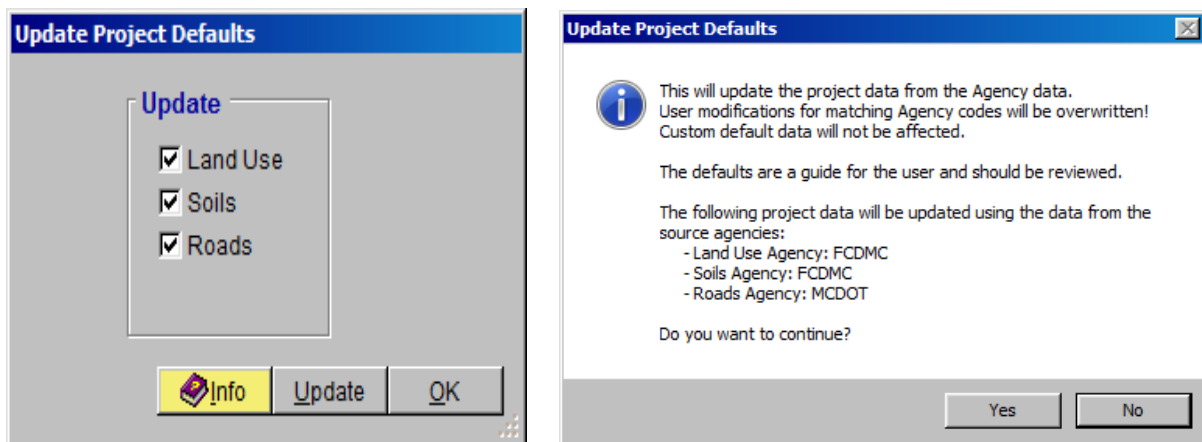
After entering the required data on the form, press the ‘**Save**’ button. Then, press ‘**OK**’ to exit the **SELECT PROJECT** form.



Then click '**OK**' to accept the data defaults (FCDMC land use, FCDMC soils, MCDOT roads, and MCDOT Inlets) from which the model to be developed will base its calculation for model parameters as well as in accessing standard design data for the model to use.

### 3.0 UPDATE PROJECT DEFAULTS

Select **File → Update Project Defaults**. Check all the boxes and then press '**Save**'. Press the '**Update**' button to update the defaults data from the source agencies identified. Press '**OK**' to continue.



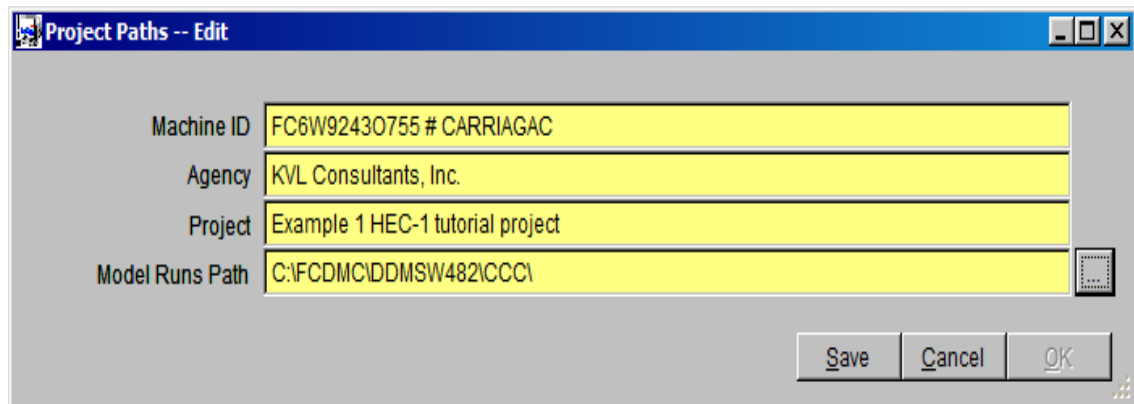
If users have already made a lot of changes in either the Land Use or Soils or both, and they want to preserve these changes, DO NOT click 'Yes'. That will overwrite all the changes already made.

### 4.0 SETTING THE MODEL RUNS PATH

When running models, the input and result files have similar file names for each project. Therefore to prevent one project overwriting the results of

another project, it is necessary to establish a unique directory for each model runs.

Go to **File → Project Paths** to establish the Model Runs Path. Press the ellipse button (...) to the right of the 'Model Runs Path' textbox and navigate to an appropriate directory. Select / choose this folder as the model runs path or press the 'Make New Folder' button if the required folder does not exist. Rename the new folder, and press 'OK' to close the 'Browse for folder' form. Note that the file path defined in the 'Model Runs Path' in the following figure is not necessarily the same as the user's path. The path depends on the location of the program installed.

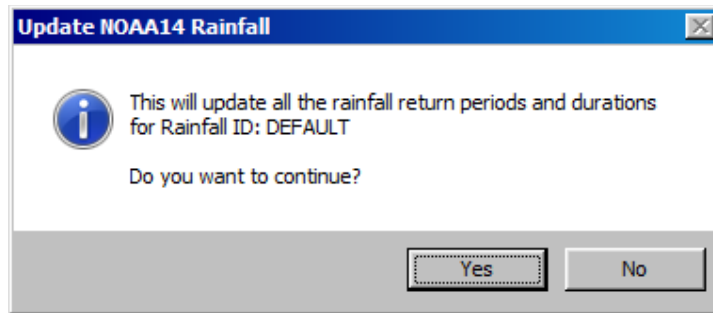


## 5.0 ESTABLISH RAINFALL DATA FOR PROJECT

On the Rainfall Ids form (**Hydrology → Rainfall Ids**), select Manual as the *Data Source* (GIS files are used for for this tutorial). For Rainfall ID, enter "Default". In the Comment box, add appropriate data description of the rainfall data being used. Click "OK" to close the "Rainfall IDs" form.

On the "NOAA 14 Rainfall ID" form (**Hydrology → Rainfall**), click the 'Maps' button to locate the project by identifying the appropriate cell from which to develop the Rainfall data. For this tutorial, cell 64 (*Map 64*) will be used. Before exiting the map, identify the sub cells where the project is located (let us use 1365).

Each map has a Township and Range address (T02NR04E for this example) to assist in locating the project. Street atlas maps (not included here) often show the Township and Range. Click the *Map Index* selector button and select 64. Then enter 1365 in the *From (No)* textbox. Do not enter any value on the *To (No)* textbox. Click the 'Save' and the 'Update' buttons to establish the project data for the rainfall.



Click 'Yes' to continue. When the 'Update' is complete, click 'OK' to exit.

The main form is titled "NOAA 14 Rainfall ID: DEFAULT". It features a "Multiple Map Selection" section on the left with input fields for "Map Index" (62), "From (No)" (1365), and "To (No)" (empty), along with a "Maps" button. Below this is a table with columns "Map", "From", and "To". The first row is populated with "62", "1365", and an empty "To" cell. To the right of the map selection is a table titled "Average Rainfall Data for ID: DEFAULT". This table has columns for return periods (2 yr, 5 yr, 10 yr, 25 yr, 50 yr, 100 yr) and rows for durations (5 Min, 10 Min, 15 Min, 30 Min, 1 Hour, 2 Hour, 3 Hour, 6 Hour, 12 Hour, 24 Hour). The data values are as follows:

	2 yr	5 yr	10 yr	25 yr	50 yr	100 yr
5 Min	0.290	0.394	0.472	0.575	0.653	0.731
10 Min	0.442	0.600	0.719	0.875	0.994	1.113
15 Min	0.548	0.743	0.891	1.085	1.232	1.380
30 Min	0.738	1.001	1.200	1.461	1.659	1.858
1 Hour	0.913	1.239	1.485	1.808	2.053	2.300
2 Hour	1.049	1.405	1.675	2.041	2.318	2.607
3 Hour	1.111	1.464	1.744	2.129	2.436	2.759
6 Hour	1.316	1.689	1.987	2.396	2.716	3.051
12 Hour	1.519	1.930	2.256	2.700	3.041	3.396
24 Hour	1.763	2.300	2.725	3.317	3.787	4.280

At the bottom of the form are buttons for "Info", "Delete", "Add", "Print...", "Update", "Rainfall ID", and "OK".

When the Rainfall data has been updated, observe the generated rainfall data for the six return intervals with varying rainfall time durations. Press 'OK' to close the "NOAA 14 Rainfall" form.

## 6.0 REVIEW SOIL DEFAULTS

Select **Hydrology** → **Soil Defaults** to view or modify Agency Soil Defaults or add a 'Custom' data. For this tutorial, custom values are not required assuming that the existing Agency Soil Defaults are sufficient. Click on the 'OK' button to close the form.



Soil ID	Book	Map Unit	XKSAT	Rock Pct	Description
6451	645	1	0.410	0.00	Antho sandy loams
6452	645	2	0.410	0.00	Antho gravelly sandy loams
6453	645	3	0.580	0.00	Antho-Carrizo-Maripo complex
6454	645	4	0.580	0.00	Antho-Carrizo-Maripo complex low precipitation
6455	645	5	0.430	0.00	Anthony sandy loam
6456	645	6	0.620	0.00	Anthony-Arizo complex
6457	645	7	0.620	0.00	Anthony-Arizo complex low precipitation
6458	645	8	0.960	0.00	Arizo cobbly sandy loam
6459	645	9	0.270	0.00	Beeline-Cipriano complex 3 to 45 percent slopes
6531	653	1	0.230	0.00	Agualt and Ripley soils
6532	653	2	0.210	0.00	Agualt and Ripley soils saline-sodic
6533	653	3	0.530	0.00	Ajo-Gunsight-Pompeii complex 3 to 25 percent slopes
6534	653	4	0.400	40.00	Akela-Rock outcrop complex 15 to 65 percent slopes
6535	653	5	0.790	0.00	Carrizo-Dateland complex 0 to 3 percent slopes
6536	653	6	1.170	0.00	Carrizo-Momoli complex 0 to 3 percent slopes

## 7.0 REVIEW LAND USE DEFAULTS

Select **Hydrology** => **Land Use Defaults** to view or modify Agency land use defaults or add a 'Custom' data. For this tutorial, custom values are not required assuming that the existing Agency Land Use Defaults are sufficient. Click on the 'OK' button to close the form.

Sort	Code	Group	IA	Rtmp	Cover	Dtheta	Kn	Description
110	Residential	0.30	5	30.0	NORMAL	0.020	Rural Residential (<= 1/5 du pe	
120	Residential	0.30	5	30.0	NORMAL	0.020	Estate Residential (1/5 du per a	
130	Residential	0.30	15	50.0	NORMAL	0.020	Large Lot Residential - Single F	
140	Residential	0.25	30	50.0	NORMAL	0.020	Medium Lot Residential - Single	
150	Residential	0.25	30	50.0	NORMAL	0.020	Small Lot Residential - Single F	
160	Residential	0.25	40	50.0	NORMAL	0.020	Very Small Lot Residential - Sin	
170	Residential	0.25	45	50.0	NORMAL	0.020	Medium Density Residential - M	
180	Residential	0.25	45	50.0	NORMAL	0.020	High Density Residential - Multi	
190	Residential	0.25	45	50.0	NORMAL	0.020	Very High Density Residential -	
200	Commercial	0.10	80	60.0	NORMAL	0.020	General Commercial (Commer	
210	Commercial	0.10	80	65.0	NORMAL	0.020	Specialty Commercial (<=50,00	
220	Commercial	0.10	80	65.0	NORMAL	0.020	Neighborhood Commercial (50	
230	Commercial	0.10	80	75.0	NORMAL	0.020	Community Commercial (100,0	
240	Commercial	0.10	80	65.0	NORMAL	0.020	Regional Commercial (500,000	
250	Commercial	0.10	80	70.0	NORMAL	0.020	Super-Regional Commercial (>	
300	Industrial	0.15	55	60.0	NORMAL	0.020	General Industrial (Industrial wt	

## 8.0 ESTABLISH MAJOR BASIN ID'S

Select **Hydrology** ➔ **Major Basins** to access the *Major Basins* data. The

software automatically establishes at least one *Major Basin* (01) when creating a new project. Since there is only one major basin in this project, there is no need to change or modify the project data as provided. Once the sub basins are established, we will return here to update *Major Basin* 01. Click on the 'OK' button to close the form.

The screenshot shows the 'Major Basins' window with the 'Details' tab selected. The 'Major Basin' section shows ID '01', Description 'Major Basin 01', and Area (sq mi) '12.3900'. The 'Rain ID' is 'DEFAULT'. The 'Modeling Options' section has 'Model This Major Basin' checked, 'Storms' set to 'Single', 'Duration' to '6 Hour', 'Tab Interval' to '5', 'No. Ordinates' to '2000', and 'Output' to '5'. The 'Reduction Factors' table has 9 rows, with the first row showing Area '0.0001' and RF '1.0000'. The 'Return Period for Steps' section shows 'Step RP' as '100'. The bottom toolbar includes buttons for Info, ReSort, Print..., Delete, Add, Update, and OK.

Reduction Factors	
	Area RF
1.	0.0001 1.0000
2.	0.5 0.9940
3.	2.8 0.9750
4.	16.0 0.9220
5.	
6.	
7.	
8.	
9.	

## 9.0 ESTABLISH PRELIMINARY SUB BASIN DATA

Select **Hydrology** → **Sub Basins** to access the sub basin data. Click on 'Add' to add the first record. On the form, enter the following:

Sub Basin	010105
Area	6.690 sq. miles
Length	5.060 miles
USGE	2760 ft (can enter Slope directly and not USGE and DSGE)
DSGE	2200 ft (can enter Slope directly and not USGE and DSGE)
Time-Area	URBAN

The data shown above is for *Sub Basin 010105*. Click 'Save' to save the data and then click 'Add' to add a second record.

Enter the following:

Sub Basin	010110
Area	5.700 sq. miles
Length	3.75 miles
USGE	2584 ft (can enter Slope directly and not USGE and DSGE)
DSGE	2195 ft (can enter Slope directly and not USGE and DSGE)
Time-Area	URBAN

**Sub Basins - MB: 01**

**Sub Basin**  
Major Basin: 01  
Sub Basin: 010110  
Sort: 4

**Sub Basin Parameters - Clark**  
Area (sq mi): 5.700  
Length (mi): 3.750  
USGE: 2584.0  
DSGE: 2195.0  
Slope (ft/mi): 103.7  
Time-Area: URBAN  
Kb: 0.018

**Rainfall Losses - Green-Ampt**  
Value Default Custom  
IA (in): 0.25 0.25  
DTHETA: 0.05 0.05  
PSIF (in): 12.49 12.49  
XKSAT: 0.014 0.014  
RTIMP (%): 30 30  
XKSAT (Bare Ground): 0.010  
Avg Vegetation (%): 50.0

**Return Period Parameters**  
Custom Tc: ☐ 2 yr ☐ 5 yr ☐ 10 yr ☐ 25 yr ☐ 50 yr ☐ 100 yr  
Tc (hrs): 0.668 0.661 0.618 0.573 0.545 0.521  
Vel (ft/s): 8.23 8.32 8.90 9.60 10.09 10.56  
R (hrs): 0.252 0.250 0.232 0.213 0.201 0.191

Buttons: Info, ReSort, Print..., Delete, Add, MB, Update, OK

The data shown above is for *Sub Basin 010110*. Click ‘Save’ to save the data and then click ‘OK’ to close the form.

## 10.0 ESTABLISH SOIL DATA

Select **Hydrology → Soils** to access the Soils data. Click on ‘Add’ to add the first record. Enter the following:

Sub Basin	010105 (Click on adjacent icon to select)
Soil ID	64512 (Click on adjacent icon to select)
Area	1.73 sq. miles

**Soils - MB: 01**

**Sub Basin**  
Major Basin ID: 01  
Sub Basin ID: 010105  
Soil ID: 64512  
Area (sq mi): 1.7300  
Area (%): 25.9

**Soil Data**  
Value Default Custom  
XKSAT: 0.010 0.010  
Rock Outcrop (%): 0.010  
Effective (%): 100

**Soil Description**  
Book Number: 645  
Map Unit: 12  
Description: Carefree cobbly clay loam 1 to 8 percent slopes

Buttons: Info, Copy, Print..., Delete, Add, MB, OK

Pressing the 'Save' button will auto-populate the Soil Description, Soil Data and Area (%) values. Click 'Add' to add a second record. Enter the following:

Sub Basin	010105 (Click on adjacent icon to select)
Soil ID	64522 (Click on adjacent icon to select)
Area	4.96 sq. miles

The screenshot shows a software window titled 'Soils - MB: 01' with a 'Details' tab. The 'Sub Basin' section contains fields for Major Basin ID (01), Sub Basin ID (010105), Soil ID (64522), Area (sq mi) (4.9600), and Area (%) (74.1). The 'Soil Data' section has a table with columns 'Value', 'Default', and 'Custom'. It contains rows for XKSAT (0.040, 0.040), Rock Outcrop (%) (0.040), and Effective (%) (100). The 'Soil Description' section has fields for Book Number (645), Map Unit (22), and Description (Contine clay loam). The bottom toolbar includes buttons for Info, Copy, Print..., Delete, Add, MB, and OK.

Click 'Save' to save the data and then click 'Add' to add a third record. Enter the following:

Sub Basin	010110 (Click on adjacent icon to select)
Soil ID	64512 (Click on adjacent icon to select)
Area	5.70 sq. miles

Click 'Save' to save the data.

After all Soils data has been entered and updated, click on the 'OK' button to close the form.

## 11.0 ESTABLISH LAND USE DATA

Select **Hydrology** → **Land Use** to access the Land Use data. Click on 'Add' to add the first record. Enter the following:

Sub Basin	010105 (Click on adjacent icon to select)
Land Use Code	110 (Click on adjacent icon to select)
Area	2.00 sq. miles

**Land Use - MB: 01**

**Land Use**

Major Basin ID: 01 Area (sq mi): 2.0000

Sub Basin ID: 010105 Area (%): 29.9

Land Use Code: 110 Rural Residential (<= 1/5 du per acre)

**Land Use Data**

	Value	Default	Custom
Initial Loss (IA)	0.30	0.30	<input type="checkbox"/>
Percent Impervious (RTIMP)	5	5	<input type="checkbox"/>
Vegetation Cover	30.0	30.0	<input type="checkbox"/>
Moisture Deficit (DTHETA)	NORMAL	NORMAL	<input type="checkbox"/>
Resistance Coefficient (Kb)	MIN	MIN	<input type="checkbox"/>

Info Copy Print... Delete Add MB OK

Click 'Save' to save the data.

Click 'Add' to add a second record. Enter the following:

Sub Basin	010105 (Click on adjacent icon to select)
Land Use Code	130 (Click on adjacent icon to select)
Area	4.69 sq. miles

**Land Use - MB: 01**

**Land Use**

Major Basin ID: 01 Area (sq mi): 4.6900

Sub Basin ID: 010105 Area (%): 70.1

Land Use Code: 130 Large Lot Residential - Single Family (1 du per acre to 2 du)

**Land Use Data**

	Value	Default	Custom
Initial Loss (IA)	0.30	0.30	<input type="checkbox"/>
Percent Impervious (RTIMP)	15	15	<input type="checkbox"/>
Vegetation Cover	50.0	50.0	<input type="checkbox"/>
Moisture Deficit (DTHETA)	NORMAL	NORMAL	<input type="checkbox"/>
Resistance Coefficient (Kb)	MIN	MIN	<input type="checkbox"/>

Info Copy Print... Delete Add MB OK

Click 'Save' to save the data.

Click 'Add' to add a second record. Enter the following:

Sub Basin	010110 (Click on adjacent icon to select)
Land Use Code	140 (Click on adjacent icon to select)
Area	5.700 sq. miles

Click 'Save' to save the data. After all Land Use data has been entered and updated, click on the 'OK' button to close the form.

## 12.0 UPDATE SUB BASIN DATA

Select **Hydrology** → **Sub Basins**. Click on the 'Details' tab to view all the data for a record. Click 'Update' to update the data.



Sub Basins - MB: 01

List Details

**Sub Basin**

Major Basin 01

Sub Basin 010105

Sort 2

**Sub Basin Parameters - Clark**

Area (sq mi) 6.690

Length (mi) 5.060

USGE 2760.0

DSGE 2200.0 [Adj](#)

Slope (ft/mi) 110.7 110.7

Time-Area URBAN

[Value](#) [Default](#) [Custom](#)

Kb 0.017 0.017 ☐

**Rainfall Losses - Green-Ampt**


	Value	Default	Custom
IA (in)	0.30	0.30	<input type="checkbox"/>
DTHETA	0.13	0.13	<input type="checkbox"/>
PSIF (in)	10.22	10.22	<input type="checkbox"/>
XKSAT	0.039	0.039	<input type="checkbox"/>
RTIMP (%)	12	12	<input type="checkbox"/>
XKSAT (Bare Ground)		0.028	<a href="#">Custom</a>
Avg Vegetation (%)		44.0	

**Return Period Parameters**

	2 yr	5 yr	10 yr	25 yr	50 yr	100 yr
Custom Tc	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Tc (hrs)	0.796	0.785	0.721	0.659	0.622	0.591
Vel (ft/s)	9.32	9.45	10.29	11.26	11.93	12.56
R (hrs)	0.356	0.350	0.319	0.288	0.270	0.256

[Info](#) [ReSort](#) [Print...](#) [Delete](#) [Add](#) [MB](#) [Update](#) [OK](#)

**Update Sub Basin Data**

 This will update Major Basin: 01 where Custom values are not checked:  
The update will include:

- Major Basin Area and Reduction Factors
- Land Use parameters
- Soil parameters

Sub Basin parameters by establishing appropriate averages of Land Use and Soils.

Tc values will be developed using the model MCUHP1.

Please Note!  
It is necessary to update Sub Basins parameters whenever land use and/or soils data have changed to ensure the correct data for running the HEC-1 model.

Do you want to continue?

[Yes](#) [No](#)

Click 'Yes' to confirm the update. Following the update, there may be a Warning message report. Address the issues and provide a comment if necessary. For this example, there is not a Warning message.

Click 'OK' to close the Sub Basins form.

## 13.0 ESTABLISH PRELIMINARY ROUTING DATA

Select **Hydrology** → **HEC-1** → **Routing** to access the Routing data. Click on 'Add' to add the first record. Enter the data as shown on the following for Route ID '010105'.

The screenshot shows the 'HEC-1 Routing Data - MB: 01' window. On the left, a table lists existing routes:

ID	Type
010105	Normal Depth
010110	Normal Depth

The 'Route' section on the right contains the following data:

- Major Basin ID: 01
- Route ID: 010105
- Type: NORMAL DEPTH
- ☐ Channel Loss

The 'Normal Depth' section contains the following data:

		Station	Elevation
LOB N	0.035	1. 510.0	99.70
Chan N	0.038	2. 1510.0	94.10
ROB N	0.035	LB 1585.0	93.60
Length	4224.0	4. 1596.0	92.20
Slope	0.0012	5. 1600.0	92.20
Max Elev	99.70	RB 1612.0	93.60
		7. 1662.0	94.90
		8. 2262.0	99.70

The 'Steps' section contains the following data:

Model	Steps	Custom
2 Year <input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5 Year <input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
10 Year <input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
25 Year <input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
50 Year <input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
100 Year <input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Custom <input type="checkbox"/>		

The bottom of the window has buttons: Info, Copy, Print..., Delete, Add, MB, and OK.

After data has been entered click '**Save**' and the '**Add**' to add another record. Enter the following data in the new record for Route ID '010110'.

The screenshot shows the 'HEC-1 Routing Data - MB: 01' window. On the left, a table lists existing routes:

ID	Type
010105	Normal Depth
010110	Normal Depth

The 'Route' section on the right contains the following data:

- Major Basin ID: 01
- Route ID: 010110
- Type: NORMAL DEPTH
- ☐ Channel Loss

The 'Normal Depth' section contains the following data:

		Station	Elevation
LOB N	0.035	1. 510.0	99.70
Chan N	0.038	2. 1510.0	94.10
ROB N	0.035	LB 1585.0	93.60
Length	6917.0	4. 1596.0	92.20
Slope	0.0020	5. 1600.0	92.20
Max Elev	99.70	RB 1612.0	93.60
		7. 1662.0	94.90
		8. 2262.0	99.70

The 'Steps' section contains the following data:

Model	Steps	Custom
2 Year <input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5 Year <input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
10 Year <input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
25 Year <input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
50 Year <input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
100 Year <input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Custom <input type="checkbox"/>		

The bottom of the window has buttons: Info, Copy, Print..., Delete, Add, MB, and OK.

**DO NOT PRESS “UPDATE NSTPS FROM HEC-1” AT THIS TIME BECAUSE THE HEC-1 MODEL HAS NOT YET BEEN ESTABLISHED!**

Press ‘**Save**’ when finished entering the data for ‘010110’. Press ‘**OK**’ to close the **HEC-1 ROUTING DATA** form.

## 14.0 ESTABLISH DIVERSION DATA

Select **Hydrology → HEC-1 → Diversions** to access the Diversion data. Click on ‘**Add**’ to add the first record. Enter the data as shown on the following for Diversion ID (KK Card) 010105.

	Inflow (cfs)	Diversion (cfs)
1.	0.0	0.0
2.	100.0	35.0
3.	200.0	70.0
4.	500.0	175.0
5.	1000.0	350.0
6.	2000.0	700.0
7.	4000.0	1400.0
8.	10000.0	3500.0
9.	20000.0	7000.0
10.	50000.0	17500.0

Enter the Retrieval ID (KK Card) and the DT Card ID as RT0105 and DT0105, respectively. These values can be left blank and DDMSW will use the Diversion ID (KK card) for these values.

Enter 35 in the % Diversion and click “**Build**”. DDMSW will fill in the diversion data based on a 35% diversion of flow.

## 15.0 ESTABLISH STORAGE DATA

Select **Hydrology → HEC-1 → Storage** to access the Storage data. Click on ‘**Add**’ to add the first record. Enter the data as shown on the following for Storage ID ‘ST0105’. The Peak Storage and Stage will be automatically entered from the model runs.

HEC-1 Storage Facilities - MB: 01

List Details Storage/Elevation/Discharge

Storage Facility

MB ID 01

Storage ID ST0115

Options

Generate New Discharge Data ☒

Low-Level Outlet (SL) ☐

Spillway (SS) ☒

Top of Dam Overflow (ST) ☒

Option Details

Spillway Characteristics (SS)

Spillway Crest Elevation 92.0

Spillway Length 50.00

Discharge Coefficient 3.00

Weir Equation Exponent 1.50

Top of Dam Overflow (ST)

Elevation Top of Dam 100.0

Length Top of Dam 300.00

Discharge Coefficient 3.00

Weir Equation Exponent 1.50

Peak Storage and Stage

Year	Volume (ac-ft)	Stage (ft)	Q (cfs)
2	213.50	96.36	818.00
5	342.50	99.80	990.00
10			1196.00
25			1454.00
50			1647.00
100			1945.00

Info ReSort Copy Print... Delete Add MB Graph OK

HEC-1 Storage Facilities - MB: 01

List Details Storage/Elevation/Discharge

Storage/Discharge Data

	Storage (ac-ft)	Elevation (ft)	Discharge (cfs)		Storage (ac-ft)	Elevation (ft)	Discharge (cfs)
1.	0.0	90.0	0	11.			
2.	100.00	92.00	100	12.			
3.	150.00	94.00	500	13.			
4.	200.00	96.00	800	14.			
5.	275.00	98.00	900	15.			
6.	350.00	100.00	1000	16.			
7.				17.			
8.				18.			
9.				19.			
10.				20.			

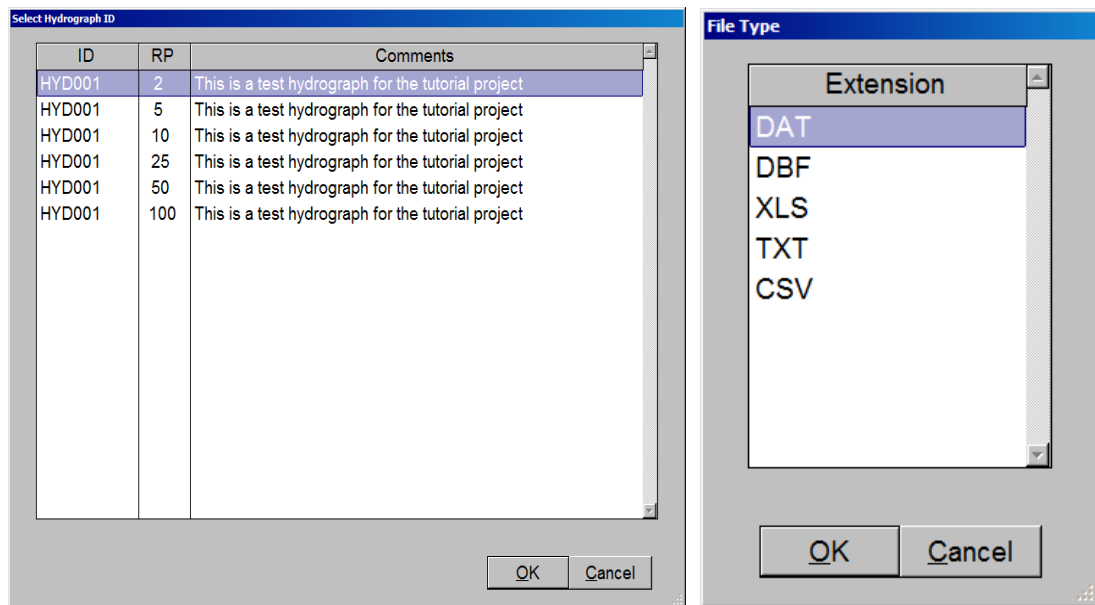
Storage ID ST0115 Use Surface Area ☐

Info ReSort Copy Print... Delete Add MB Graph OK

## 16.0 ESTABLISH HYDROGRAPH DATA (QI CARD)

This example is going to use a hydrograph. Initially it is necessary to establish the Hydrograph IDs. Select **Hydrology** → **HEC-1** → **Hydrograph IDs** to access the Hydrograph IDs data. Click on 'Add' to add the first record. Enter the Hydrograph ID, the drainage area and the time interval for the hydrograph data (NMIN).





Now click '*Import*' and select the type of file (DAT, DBF, XLS, TXT or CSV). The hydrographs for this example are located in the Modlrns\KvlExample1 directory. Select Hyd001-2.dat and click "OK" and follow the screen instructions. Repeat this process for the 5, 10, 25, 50 and 100 year hydrographs.

## 17.0 CREATE DRAFT HEC-1 MODEL

Select **Hydrology** → **HEC-1** → **Network** to access the model Network data.

HEC-1 Model Network - MB: 01

Look for  ☐ Exclude

Sort	ID	Type	Retrieve ID	Combine	Area
10		ID			
20	010105	Basin			
30	010105	Divert	DT0105		
40	010105	Route			
50	010110	Basin			
60	010105	Retrieve	DT0105		
70	010105	Combine		3	
80	010110	Route			
90	HYD001	Hydrograph			
100	HYD001	Combine		2	
110	ST0115	Storage			

**Model Network**

MB

Sort

Type

Basin	Divert	ID
Combining	Retrieve	*
Route	Storage	KM Comment
Hydrograph	Special Code	

This is the HEC-1 tutorial program example.

Info ReSort Copy Print... Delete Add MB Create Draft OK

Click on 'Add' to add the first record and select ID from the Select Type List and enter the following: Comment: This is the HEC-1 tutorial program example.

Click 'Save' and then Click 'Basin' and select 010105 from the list. Click 'Save' and then Click 'Divert' and select 010105 from the list.

Click 'Save' and then Click 'Route' and select 010105 from the list. Select Normal Depth as the Route Type. Click 'Save' and then Click 'Basin' and select 010110 from the list.

Click 'Save' and then Click 'Retrieve' and select 010105 from the list. Click 'Save' and then Click 'Combine. Modify the Combine No to 3. Click 'Save' and then Click 'Route' and select 010110 from the list.

Click 'Save' and then Click 'Hydrograph' and select HYD001 from the list.

Click 'Save' and then Click 'Combine. Combine No defaults to 2 and this is OK. Click 'Save' and then Click 'Storage' and select ST0105 from the list.

After all data has been entered click 'Create Draft' and the following file is created.

```

ID      KUL Consultants, Inc.
ID      U482_KULEX1 - Example 1 HEC-1 tutorial project
ID      100 Year
ID      6 Hour Storm
ID      Unit Hydrograph: Clark
ID      Storm: Single
ID      12/08/2014
ID This is the HEC-1 tutorial program example.
*DIAGRAM
IT      5              0      2000
IO      5
IN      15
*
*
KK010105  BASIN
BA      1.0
PB      4.0
PC 0.000  0.008  0.016  0.025  0.033  0.041  0.050  0.058  0.066  0.074
PC 0.087  0.099  0.118  0.138  0.216  0.377  0.834  0.911  0.931  0.950
PC 0.962  0.972  0.983  0.991  1.000
LG 0.15   0.25   4.50   0.50   50
UC 1.0    1.0
UA 0      5      16      30      65      77      84      90      94      97
UA 100
*
KK010105  DIVERT
DTDT0105  0      100
DI 0      100    200    1000   10000
DQ 0      50     100     500    5000
*
KK010105  ROUTE
RS 5      FLOW
RC 0.016  0.016  0.016  1000   0.015
RX 10     25     50     52     82     84     100    110
RV 15.0   15.0   15.0   0.0    0.0    15.0   15.0   15.0
*
KK010110  BASIN
BA 1.0
LG 0.15   0.25   4.50   0.50   50
UC 1.0    1.0
UA 0      5      16      30      65      77      84      90      94      97
UA 100
*
KK010105RETRIEVE
DRDT0105
*
KK010105  COMBINE
HC 3
*
KK010110  ROUTE
RS 5      FLOW
RC 0.016  0.016  0.016  1000   0.015
RX 10     25     50     52     82     84     100    110
RV 15.0   15.0   15.0   0.0    0.0    15.0   15.0   15.0
*
KKHYD001  HYDRO

```



```

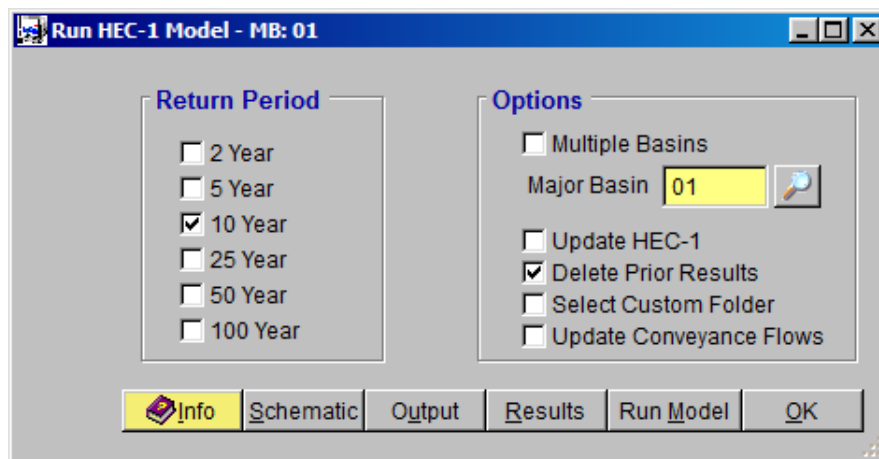
KKHYD001  HYDRO
IN 5
BA 3.76
QI 51 82 161 325 386 473 693 840 890 1002
QI 1069 1085 1120 1252 1401 1663 1721 1967 2185 2261
QI 2543 2718 2458 2162 1876 1645 1443 1249 1044 836
QI 705 587 477 391 336 297 267 240 219 201
QI 184 168 156 146 137 129 120 111 103 96
QI 89 84 79 74 70 65 61 56 53 49
QI 47 44 43 41 39 37 35 34 32 30
*
IN 15
*
KKHYD001 COMBINE
HC 2
*
KKST0115 STORAGE
KO
RS 1 STOR
SU 0.0 10.0 100 1000 10000
SE 85.0 90.0 95.0 100.0 105.0
SS 95.0 50.00 3.10 1.50
ST 100.0 150.00 3.00 1.50
*
ZZ

```

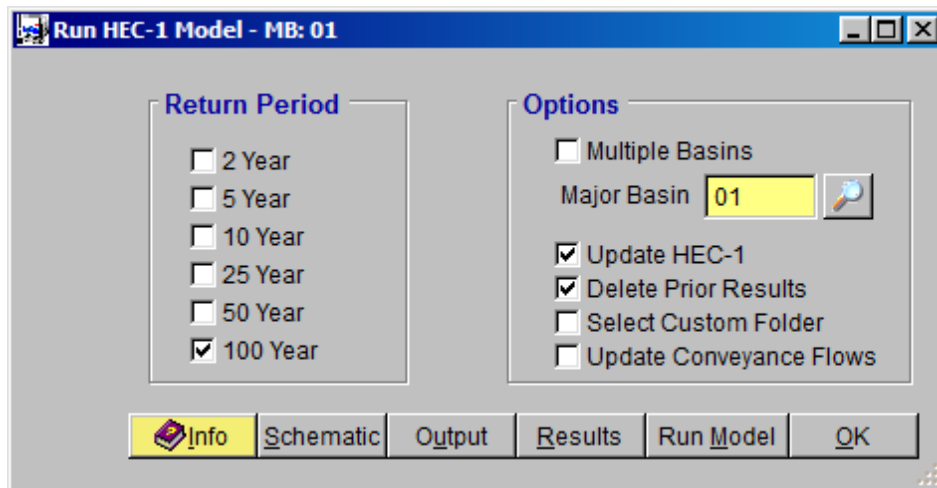
## 18.0 RUN DRAFT HEC-1 MODEL

Select **Hydrology** → **HEC-1** → **Model** to access the HEC-1 model.

Check the '10 Year' Return Period and the 'Delete Prior Results' option. Uncheck all other return periods and options.



Click 'Save'. Click 'Run Model' to run the Draft HEC-1 Model. If the model runs correctly, it means the HEC-1 Network is fine. If there are no errors, run the model for the 100-year Return Period. Check the Update HEC-1 checkbox. Press Save to save the selections made and then click Run Model button.



**Run HEC-1 Model - MB: 01**

**Return Period**

- ☐ 2 Year
- ☐ 5 Year
- ☐ 10 Year
- ☐ 25 Year
- ☐ 50 Year
- ☒ 100 Year

**Options**

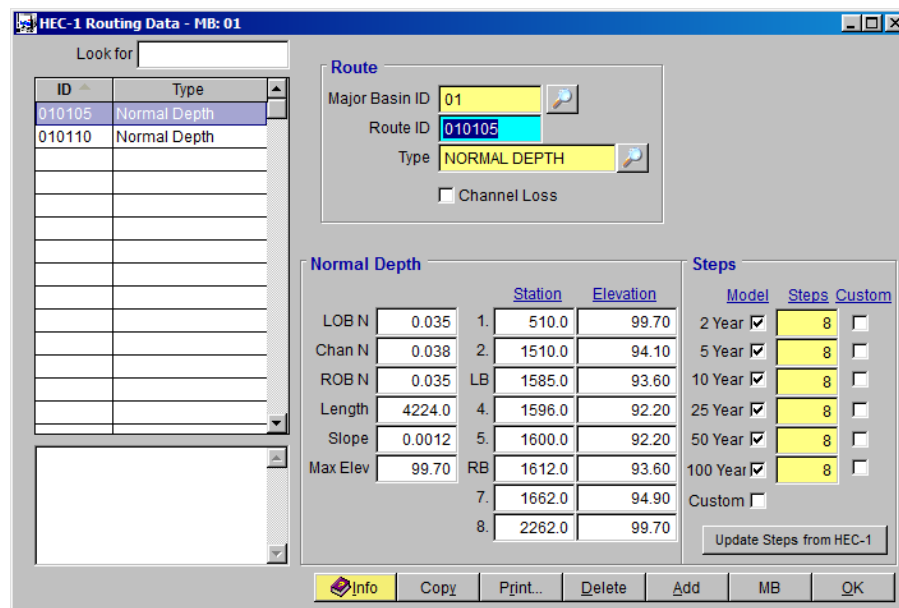
- ☐ Multiple Basins
- Major Basin:
- ☒ Update HEC-1
- ☒ Delete Prior Results
- ☐ Select Custom Folder
- ☐ Update Conveyance Flows

Buttons: Info, Schematic, Output, Results, Run Model, OK

This previous model run has performed an update on the HEC-1 model based on the model framework that was built. The update has integrated real project data into the model. To close the **RUN HEC-1 MODEL** form, press **OK**.

## 19.0 UPDATE ROUTING STEP VALUES

Select **Hydrology → HEC-1 → Routing** to access the Routing data. Click on the 'Update from HEC-1' button to update the Steps. A note will pop up saying that the HEC-1 model will run three times and the 'Steps' field for all routing channels will be updated if the custom checkbox is not filled in. Select 'Yes'. The following will be the results for **Route ID 010105**. Press **OK** to close the **HEC-1 ROUTING DATA** form.



**HEC-1 Routing Data - MB: 01**

Look for:

ID	Type
010105	Normal Depth
010110	Normal Depth

**Route**

Major Basin ID:

Route ID:

Type:

☐ Channel Loss

**Normal Depth**

	Station	Elevation
LOB N	0.035	
Chan N	0.038	
ROB N	0.035	
Length	4224.0	
Slope	0.0012	
Max Elev	99.70	
	1. 510.0	99.70
	2. 1510.0	94.10
	LB 1585.0	93.60
	4. 1596.0	92.20
	5. 1600.0	92.20
	RB 1612.0	93.60
	7. 1662.0	94.90
	8. 2262.0	99.70

**Steps**

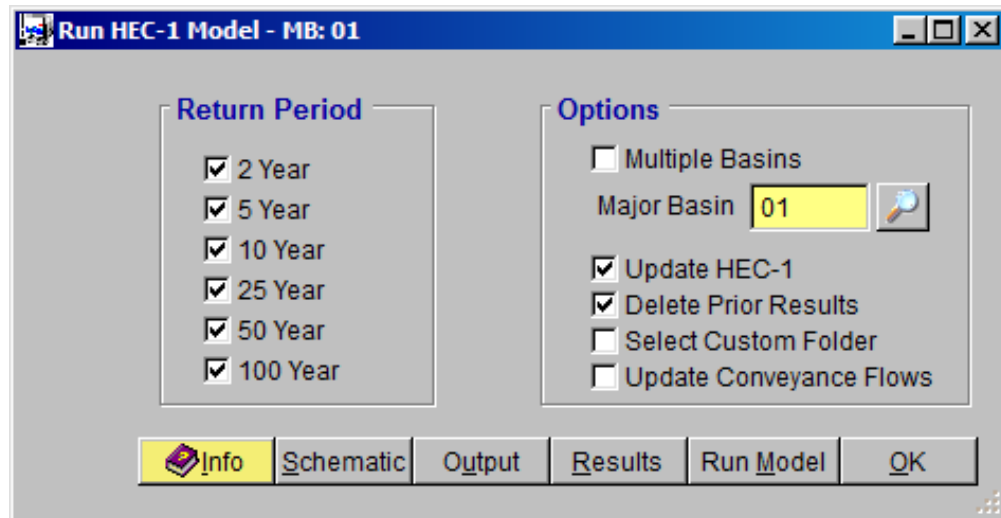
	Model	Steps	Custom
2 Year	<input checked="" type="checkbox"/>	<input type="text" value="8"/>	<input type="checkbox"/>
5 Year	<input checked="" type="checkbox"/>	<input type="text" value="8"/>	<input type="checkbox"/>
10 Year	<input checked="" type="checkbox"/>	<input type="text" value="8"/>	<input type="checkbox"/>
25 Year	<input checked="" type="checkbox"/>	<input type="text" value="8"/>	<input type="checkbox"/>
50 Year	<input checked="" type="checkbox"/>	<input type="text" value="8"/>	<input type="checkbox"/>
100 Year	<input checked="" type="checkbox"/>	<input type="text" value="8"/>	<input type="checkbox"/>
Custom	<input type="checkbox"/>		

Update Steps from HEC-1

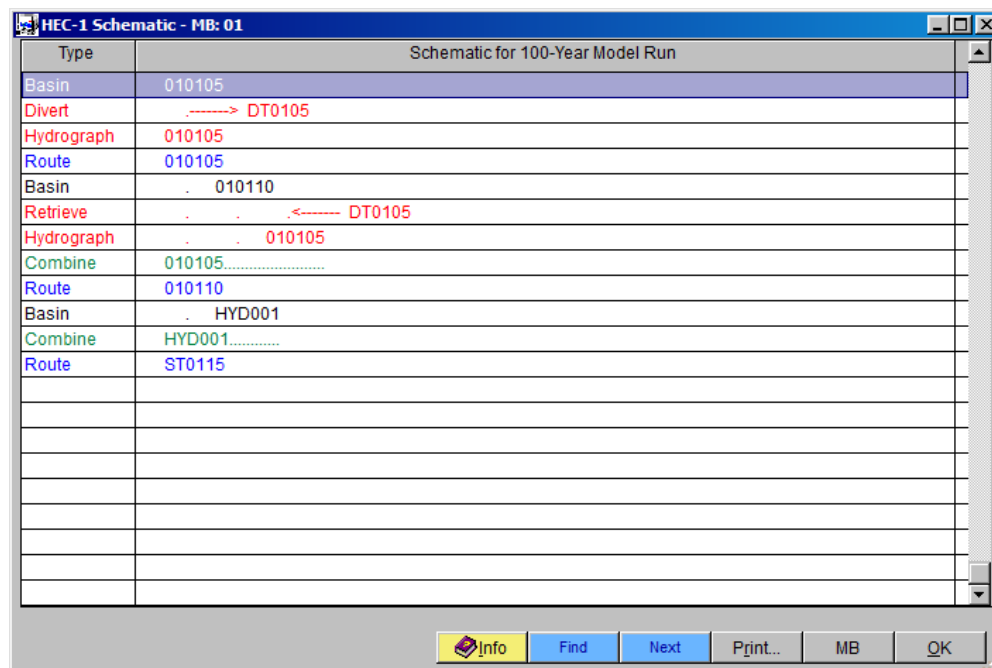
Buttons: Info, Copy, Print..., Delete, Add, MB, OK

## 20.0 RUN FINAL HEC-1 MODEL FOR ALL RETURN PERIODS

Select **Hydrology** → **HEC-1** → **Model** to access the HEC-1 model. Check all Return Periods, and the *Update HEC-1* and *Delete Prior Results* checkbox options.



Click '**Run Model**' to run the updated HEC-1 model for all return periods. If the model runs correctly, it means the HEC-1 network and data are fine. The results can be viewed by clicking '**Results**'. A full output file can be viewed with the '**Output**' button, selecting the specific output file to view and pressing '**OK**'. The 100-Year schematic can be viewed by pressing the '**Schematic**' button.



## 21.0 VIEW FLOW SUMMARY

Select **Hydrology** ➔ **HEC-1** ➔ **Flow Summary** to access the HEC-1 model results. Click '**View**' to view other summary items.


[illegible]

**Model View**

**View Option**

View

Option

 Info

Select Option

Option
All
Hydrograph
Routed
Combined

Storage

OK Cancel

Select View

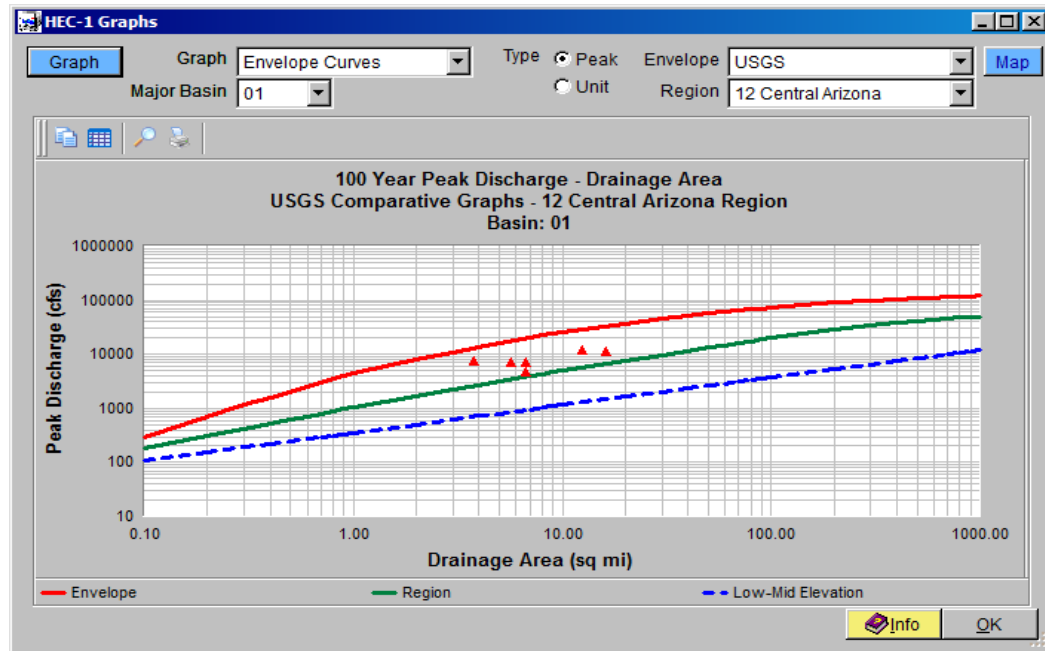
Model

- Flows
- Volumes (IN)
- Volumes (AF)
- Attenuation/Velocity

OK Cancel

## 22.0 GRAPH HEC-1 RESULTS

Select **Hydrology** → **HEC-1** → **Graph** to access the Graphing module. Enter the appropriate data for your location and click the '**Graph**' button as follows:



## 23.0 BACKUP PROJECT

Select **File** → **Project Management** to access the Project Management module. Select '**Backup Project**' as the **Action** and '**KVLEXAMPLE1A**' as the project (use the adjacent icon to select). Click the '**Backup**' button to backup the project and select the directory where your backup file should go. Finally, click '**Yes**' after a directory has been chosen.

